AD 729582

EERL 71-2

# INVESTIGATION of TRITIATED LUMINOUS COMPOUNDS

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
Springfield, Va. 22151

DDC
RECEIVED
SEP 21 1971
F

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Monitoring

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

| BIBLIOGRAPHIC DATA SHEET | 1. Report No. EERL 71-2 | 2. | 3. Recipient's Accession No. |
|---|---|---|---|
| 4. Title and Subtitle<br>Investigation of Tritiated Luminous Compounds | | | 5. Report Date<br>June 1971<br>6. |
| 7. Author(s) Stephen L. Kaufman, Mayme C. Colvin, Robert Lieberman, A.A.Moghissi, Blair F.Rehnberg and Robert C. McMillan | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address<br>Environmental Protection Agency<br>Eastern Environmental Radiation Laboratory<br>P. O. Box 61<br>Montgomery, Alabama 36101 | | | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. Sponsoring Organization Name and Address<br>Environmental Protection Agency<br>Office of Research & Monitoring<br>Rockville, Maryland 20852 | | | 13. Type of Report & Period Covered<br>14. |

15. Supplementary Notes
Supported by funds from the Mobility Equipment Research & Development Center, U.S.Army, Fort Belvoir, Va.

16. Abstracts

The cutaneous and gastrointestinal tract absorption of four tritiated luminous compounds was studied in experimental animals. The percent absorption of the individual compounds via the cutaneous route varied from 0.10 to 8.83 percent and via the gastro-intestinal route from 0.67 to 21.55 percent. The data show a positive correlation between the relative absorption of the individual luminous compounds through both the cutaneous and gastrointestinal routes. Tritium activity was eliminated in two components. A slow component was seen to represent tritium activity in the form of tritiated water (HTO), while a more rapid component was thought to be tritium incorporated in other compounds soluble in urine and other body fluids.

17. Key Words and Document Analysis. 17a. Descriptors

Luminous Compounds; Tritium; GI Tract Absorption; Cutaneous Absorption; Biological Half-Life.

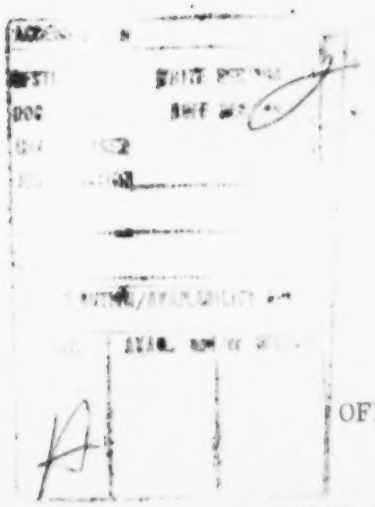
17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 6. Biological & Medical Sciences

| 18. Availability Statement | 19. Security Class (This Report) | 21. No. of Pages |
|---|---|---|
| Release unlimited | UNCLASSIFIED | 29 incl. front cover |
| | 20. Security Class (This Page) UNCLASSIFIED | 22. Price |

FORM NTIS-35 (10-70)

USCOMM-DC 40329-P71



OFFICE OF RESEARCH AND MONITORING
RADIATION RESEARCH

EASTERN ENVIRONMENTAL RADIATION LABORATORY

TECHNICAL REPORTS

Technical reports of the Eastern Environmental Radiation Laboratory are available from the National Technical Information Service, Springfield, Va. 22151, when a PB number is indicated after the title. Microfiche copies are $0.95; prices for paper copies are indicated after the PB number. Bulk order prices are available from NTIS. The PB number should be cited when ordering.

| | Title |
|---|---|
| | Radiological Survey of Major California Nuclear Ports (April 1967) (PB 178 728 $6.00) |
| | Radiological Survey of Hampton Roads, Virginia (January 1968) (AD 683 208 $6.00) |
| BRH/SERHL 70-1 | Laboratory Examination of a Ruptured 50-mg Radium Source (May 1970) (PB 191 810 $3.00) |
| RO/EERL 71-1 | Development of Ion Exchange Processes for the Removal of Radionuclides from Milk (January 1971) (PB 198 052 $0.50) - ORDER FROM SOD |
| EERL 71-2 | Investigation of Tritiated Luminous Compounds (June 1971) |

# INVESTIGATION of TRITIATED LUMINOUS COMPOUNDS

Stephen L. Kaufman, M.C.[1]
Mayme C. Colvin[2]
Robert Lieberman[3]
A.A. Moghissi, Ph.D.[4]
Blair F. Rehnberg[2]
Robert C. McMillan[5]

EASTERN ENVIRONMENTAL RADIATION LABORATORY
P.O. BOX 61
Montgomery, Alabama 36101

Authors' present addresses:

1 The Johns Hopkins University
2 Division of Biological Effects, BRH
3 Eastern Environmental Radiation Laboratory
4 Western Environmental Research Laboratory
5 U.S. Army Mobility Equipment Research And Development Center

June 1971

This project was supported by funds from the Mobility Equipment Research and Development Center, U.S. Army, Fort Belvoir, Va.

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Monitoring
Radiation Research
Rockville, Maryland, 20852

This work was initiated while this Laboratory was a component of the Bureau of Radiological Health, U. S. Department of Health, Education and Welfare.

# FOREWORD

The Environmental Protection Agency has the responsibility of carrying out a national program for measuring the population exposure to ionizing and nonionizing radiation and for assessing the radiological quality of the environment.

The Eastern Environmental Radiation Laboratory (EERL) contributes to this program through research, applied technology, and training. These endeavors include the development of analytical and radiochemical methodology and the planning and presentation of courses on the radiological health aspects of ionizing and nonionizing radiation.

Until December 1970, the EERL was part of the Department of Health, Education, and Welfare and was known as the Southeastern Radiological Health Laboratory. At that time, pursuant to the President's Reorganization Plan No. 3, the Laboratory was transferred from the Bureau of Radiological Health, DHEW, to the newly created Environmental Protection Agency and given its present designation.

The technical reports of the EERL provide a rapid and comprehensive means for publishing results of intramural and contractor projects. The reports are distributed to regional, State, and local radiological health agencies, to universities and libraries, to other government and private agencies, and to interested individuals. Readers are encouraged to send their comments on the material contained in these reports to the Office of Research and Monitoring.

William A. Mills

William A. Mills, Ph.D.
Acting Chief
Radiation Research

## PREFACE

Radioactive luminous compounds have been of public health significance since the discovery in the 1920's of toxic effects of radium-containing luminous dial paints on workers in the dial painting industry. Since then such compounds have been largely replaced by other compounds containing presumably less toxic radionuclides. One radionuclide widely used as an activating agent in luminous compounds is tritium. The following report represents a study of the absorption and metabolism of several commercially available tritium-containing luminous compounds in the mammalian organism.

This information should be helpful to those involved in the dial- and instrument-painting industries and other users of luminescent devices.

Charles R. Porter
Director
Eastern Environmental Radiation
Laboratory

CONTENTS


| | Page |
|---|---|
| FOREWORD | iii |
| PREFACE | v |
| LIST OF TABLES AND FIGURES | viii |
| ABSTRACT | ix |
| ACKNOWLEDGMENT | x |
| 1. INTRODUCTION | 1 |
| 2. METHODS | 1 |
| 2.1 LUMINOUS COMPOUNDS (IDENTIFICATION) | 1 |
| 2.2 RAT STUDY | 2 |
| 2.3 CAT STUDY | 2 |
| 2.4 CALCULATIONS | 3 |
| 3. RESULTS | 4 |
| 3.1 URINARY EXCRETION CURVES | 4 |
| 3.2 URINE DISTILLATION EXPERIMENTS | 4 |
| 3.3 TRITIUM ABSORPTION | 5 |
| 4. DISCUSSION | 5 |
| 5. CONCLUSIONS | 7 |
| APPENDIX A | 13 |
| APPENDIX B | 14 |

## TABLES


| | | Page |
|---|---|---|
| 1. | Least squares regression analysis formulas of tritium elimination curves | 9 |
| 2. | Effective half-lives (days) of rapid versus slow components in rats and cats | 10 |
| 3. | Urine distillation experiments in rats | 10 |
| 4. | Percent absorption of tritium activity from luminous compounds | 11 |
| 5. | Percent total urinary tritium elimination due to various components (time 0 to infinity) | 11 |


## FIGURES


| | | |
|---|---|---|
| 1. | Rat skin absorption of tritium activity from luminous compounds | 12 |
| 2. | Cat GI absorption of tritium activity from luminous compounds | 12 |

## ABSTRACT

The cutaneous and gastrointestinal tract absorption of four tritiated luminous compounds was studied in experimental animals. The percent absorption of the individual compounds via the cutaneous route varied from 0.10 to 8.83 percent and via the gastrointestinal route from 0.67 to 21.55 percent. The data show a positive correlation between the relative absorption of the individual luminous compounds through both the cutaneous and gastrointestinal routes.

Tritium activity was eliminated in two components. A slow component was seen to represent tritium activity in the form of tritiated water (HTO), while a more rapid component was thought to be tritium incorporated in other compounds soluble in urine and other body fluids.

## ACKNOWLEDGMENT

We are indebted to Mrs. Mae Williams who carried out the sample preparation and counting throughout this experiment.

The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products by the Environmental Protection Agency.

# INVESTIGATION OF TRITIATED LUMINOUS COMPOUNDS

## 1. INTRODUCTION

Radioactive luminous compounds represent a significant potential source of radiation exposure to both industrial workers and the general public. Luminous compounds with tritium as the activating agent are widely used in the painting of watch and instrument dials and in the production of radioluminescent light sources. It is therefore desirable to have accurate information regarding the degree of uptake and the metabolic behavior of tritiated luminous compounds in general, and comparative data regarding the specific tritiated compounds now in use.

In the present study the gastrointestinal tract and cutaneous absorptions of four commercially available tritiated luminous compounds were investigated. Cutaneous absorption of the tritiated compounds was studied in the rat, while the cat was chosen as the experimental animal for studies of GI tract absorption.

## 2. METHODS

### 2.1 LUMINOUS COMPOUNDS (IDENTIFICATION)

All tritiated luminous compounds now known to be in use and those planned to be used in selected devices were investigated. Four compounds were involved and each was administered to 10 test animals in both the cutaneous and GI tract uptake studies. Ten "control" animals given tritiated water were used in each set of studies. The tritiated compounds evaluated were those produced by:

- 3M Company (herein abbreviated as MH) specific activity 200 mCi/g or 2.0 mCi per 10-mg dose.
- Canrad Precision Company (abbreviated as CH) specific activity 250 mCi/g or 2.5 mCi per 10-mg dose.
- Radium Chemical Company (abbreviated as RH) specific activity 250 mCi/g or 2.5 mCi per 10-mg dose.
- New England Nuclear Corporation (abbreviated as NH) specific activity 600 mCi/g or 6.0 mCi per 10-mg dose.

(See appendix A)

## 2.2 RAT STUDY

Each rat was weighed, the hair clipped and shaved from its back, and then put into a metabolic cage for a 24-hour acclimation period prior to cutaneous exposure. The following day 10 mg of compound was weighed into an area of 1 $cm^2$ on a piece of plastic wrap which was mounted on surgical bandage. The bandage was carefully taped onto the rat's back by placing the animal upon the bandage with the compound facing the shaved area. An additional wider piece of surgical tape was placed around the rat's body to hold the compound securely in place.

Eight hours after application of the compound the bandages were removed and the skin thoroughly washed and rinsed to remove all traces of luminous compound. The procedure consisted of three washes using Triton in warm water followed by three rinses using tap water. A new gauze pad (2" x 2") was used with each wash and rinse. The skin was then checked with a fluorescent lamp and any remaining compound was removed with a gauze pad and tap water.

Abrasions from shaving occasionally occurred. When this happened the compound was applied to unabraded skin. The washing step was carried on with extreme care to avoid contaminating the wound with the test material. Notes were kept on animals having abrasions but no absorption differences were observed. Urine samples were collected from the rats every 12 hours for the first 72 hours and each 24 hours thereafter for periods of from 23 to 30 days. Clean separator funnels were inserted at the beginning of each collection period. Two ml of mineral oil were added to the urine collection vials to prevent evaporation of the sample. The urine sample volumes were noted and an aliquot was counted in a liquid scintillation counter. Results were obtained as nanocuries of tritium per ml of urine.

## 2.3 CAT STUDY

Cats were acclimated for 7 to 10 days in metabolic cages prior to oral administration of luminous compound. The four compounds discussed previously were fed to cats in 10-mg amounts by fashioning cups out of canned food, weighing the compound into the cup, and forming balls so the material was in the center. After being without food overnight the cats usually ate the ball in one bite. Urine was collected every 24 hours for periods of from 43 to 73 days. These specimens were counted in the same manner as those of the rats.

## 2.4 CALCULATIONS

The average daily urinary tritium activity (nCi/ml) divided by the dose of compound administered was plotted as a function of time for each experimental group of 10 animals. These urinary elimination data were submitted to least squares regression analysis using a programable electronic calculator. The least square curves were fitted to the experimentally derived data points and the effective half-lives for each compound were computed from the resulting data. As two components of tritium elimination were observed for each luminous compound after both GI and cutaneous absorption, two half-lives were obtained for each compound by each route. The areas under curves representing each of the two individual components were obtained by integration and the ratio of each area to the total area under the excretion curve of the particular compound was computed as the percent of total urinary tritium activity due to each component.

The tritium absorbed was determined in the following manner: Total urinary output of tritium for each animal over the time period followed was multiplied by a factor (2.8 for rats and 2.1 for cats) which relates total water output (urine, feces, sweat, breath, etc.) of each species to the urinary output.[1] The product so obtained gives the total tritium eliminated via all routes.

A correction factor was derived which when multiplied by the observed total tritium output gives the total tritium output which would have been obtained if the urinary output were followed to time equals infinity instead of for a finite number of days. This factor and its derivation are given in appendix B. For the period of time the animals were followed, the correction necessary was found to change experimental values slightly (see table 4).

This total tritium output divided by the dose administered gives the fraction of tritium absorbed.

In order to investigate whether the observed two-component elimination of tritium activity was due to the presence of tritium in more than one chemical compound or merely an artifact of absorption,

---

[1] SPECTOR, WILLIAM S., Editor, Handbook of Biological Data, National Academy of Sciences, National Research Council, p. 339, W. B. Saunders Co., Philadelphia 1956.

urine from rats administered a tritiated luminous compound (CH) 24 hours previously was divided into two aliquots. The first aliquot was counted for tritium activity directly while the second was distilled and the distillate counted. A similar procedure was performed on the urine of rats to which tritiated water was administered 24 hours previously and luminous compound 8 days previously.

## 3. RESULTS

### 3.1 URINARY EXCRETION CURVES

Figures 1 and 2 show the observed daily urinary tritium activity (average of the 10 animals in each group) divided by the total activity for the different luminous compounds applied by cutaneous absorption in rats and by GI absorption in cats, respectively. These curves all exhibit two components: A rapid component being present for the initial 3-4 days post dose which then yields to a component with a slower rate of fall. The excretory curve obtained from the control animals given HTO exhibits only a single component with a slope similar to that of the slow component of the curves of the experimental animals. The curves are indicative of the relative tritium absorption from the various luminous compounds. The formulas obtained by least squares regression analysis corresponding to the daily urinary tritium activity curves in figures 1 and 2 are shown in table 1. The curves are seen to represent the sum of two exponential equations. The effective half-lives corresponding to the rapid and the slow components of elimination are shown in table 2. The slow component half-lives are of essentially the same order of magnitude as those of control animals to which HTO was administered.

### 3.2 URINE DISTILLATION EXPERIMENTS

Data showing tritium activity in untreated urine and in urine distillate for various parameters described below are shown in table 3.

Activity in the distillate is, of necessity, due to tritium present in the chemical form of HTO and possibly to any volatile tritiated compounds which might have been present. Untreated urine activity is the sum of HTO activity and the activity of other tritiated compounds that may be present in the urine. At 24 hours after exposure to luminous paint, both the rapid and slow half-life components of tritium elimination are present. Eight days after exposure, however, activity due to the fast half-life component is negligible, and essentially all activity is due to the slow component.

Eight days after exposure the ratio of distilled to untreated urine activity approaches unity. This is also the case 24 hours after exposure of rats to HTO. This indicates that the slow component of tritium activity is due to tritium absorbed from the luminous compound as HTO. Twenty-four hours after exposure to the luminous compound, however, only 20 percent of total tritium activity comes over in the distillate. This indicates that the rapid half-life component of tritium activity is due to tritiated compounds other than HTO present as solute in the urine.

### 3.3 TRITIUM ABSORPTION

Table 4 shows the percentage of total tritium activity absorbed through the skin and the GI tract for each luminous compound. The experimentally observed percentage at the termination of the experiment and the percentage corrected for tritium activity which would have been obtained had the urine been collected to time equals infinity are given. There is very little if any difference between the observed and corrected values in all cases. The relative absorption among the individual compounds is the same for both routes of absorption in that in each instance the MH compound has the highest degree of absorption followed by CH, RH and NH in that order.

Table 5 shows the urinary tritium elimination due to the rapid and slow components, respectively. With the exception of the MH compound, which has the lowest relative fraction of activity due to the fast component after both cutaneous and GI absorption, GI absorption uniformly results in a greater proportion of total tritium activity due to the rapid component.

## 4. DISCUSSION

The study was concerned with the absorption and subsequent metabolism of four tritiated luminous compounds. The compounds were introduced into the animals via skin absorption (rats) and the GI tract (cats).

A study of the daily urinary tritium excretion after administration of all four of these compounds via both routes revealed a two-component elimination. A rapid component with a half-life of less than one day was invariably found. A slower component was also found, with a half-life of from 3.2 to 4.2 days in rats administered the compounds through the skin and from 7.7 to 9.8 days in cats given the compounds orally. When tritiated water was administered to both types of experimental animals only one component of urinary elimination was observed

during the time period studied, with a half-life similar to that of the slower component found in the animals to which the tritiated luminous compounds were administered. This observation suggested that the tritium uptake from the luminous compounds was due in part to the absorption of tritiated water which was eliminated as the slow component, and in part to the absorption of other soluble tritiated compounds which were eliminated at a more rapid rate. This hypothesis was shown to be correct by the studies comparing tritium activity in both raw and distilled urine samples from rats to which a luminous compound had been administered at various time intervals previous to urine collection.

This introduces some difficulties in the calculation of the percent absorption of total tritiated activity from the luminous compounds studied. Most previous work has been on the absorption of tritium in the form of tritiated water. As this compound is known to distribute equally within the total body water compartments and all bodily excretions, the calculation of the percent of absorption is relatively simple. It is not known, however, whether the rapid component of tritium activity observed in this study distributes equally in the various body water compartments and aqueous excretions.

It was nevertheless assumed that both components were present in equal concentrations in the water of all bodily excretions. The total amount of tritium from both components excreted by the animals via the urine was determined. This was multiplied by a factor relating water excretion from all routes (urine, breath, feces, etc.) to urine excretion, giving the total tritium excretion by all routes. From this latter value the percent absorption was calculated.

This assumption is certainly valid for the slow component, consisting of tritiated water. Whether it is equally valid for the rapid component also is not yet known with certainty as the exact chemical nature of the compound(s) composing this component is not now known. However, being water soluble, these compounds would be expected to be excreted in body fluids other than urine.

The method of calculation employed would perhaps lead to a slight overestimation of the rapid component absorption. Due to the rapid excretion of this component, however, the significance of this error would be very small, as far as radiation dose to the living organism is concerned.

## 5. CONCLUSIONS

The data showed a positive correlation between the relative absorption of the various luminous compounds through both the GI and cutaneous routes. In both instances the MH compound had the highest rate of absorption, followed in order by the CH compound, RH compound, and NH compound. In addition to having the highest total tritium absorption, the MH compound had the greatest percentage of the total activity due to the slow component. In case of an accidental exposure to a luminous compound, therefore, this particular compound would result in the greatest radiation dose, due both to its greater absolute degree of absorption and the fact that a higher proportion of the activity once absorbed would be eliminated with the slower half-life.

**Table 1. Least Squares Regression Analysis Formulas of Tritium Elimination Curves**

| | |
|---|---|
| **Cutaneous Absorption in Rats** | |
| Compound | |
| MH | $A = (5.4 \times 10^{-4})\, e^{-\frac{\ln 2}{0.5} t} + (2.1 \times 10^{-4})\, e^{-\frac{\ln 2}{4.2} t}$ |
| RH | $A = (3.4 \times 10^{-5})\, e^{-\frac{\ln 2}{0.5} t} + (0.5 \times 10^{-5})\, e^{-\frac{\ln 2}{3.2} t}$ |
| NH | $A = (2.5 \times 10^{-5})\, e^{-\frac{\ln 2}{0.3} t} + (0.3 \times 10^{-5})\, e^{-\frac{\ln 2}{3.2} t}$ |
| CH | $A = (1.1 \times 10^{-4})\, e^{-\frac{\ln 2}{0.4} t} + (0.2 \times 10^{-4})\, e^{-\frac{\ln 2}{3.5} t}$ |
| HTO Control | $A = (3.7 \times 10^{-3})\, e^{-\frac{\ln 2}{3.2} t}$ |
| **GI absorption in Cats** | |
| MH | $A = (5.1 \times 10^{-4})\, e^{-\frac{\ln 2}{0.6} t} + (1.0 \times 10^{-4})\, e^{-\frac{\ln 2}{9.8} t}$ |
| RH | $A = (150 \times 10^{-5})\, e^{-\frac{\ln 2}{0.4} t} + (0.7 \times 10^{-5})\, e^{-\frac{\ln 2}{8.8} t}$ |
| NH | $A = (5.5 \times 10^{-5})\, e^{-\frac{\ln 2}{0.6} t} + (0.3 \times 10^{-5})\, e^{-\frac{\ln 2}{8.3} t}$ |
| CH | $A = (8.7 \times 10^{-4})\, e^{-\frac{\ln 2}{0.4} t} + (0.1 \times 10^{-4})\, e^{-\frac{\ln 2}{7.7} t}$ |
| HTO Control | $A = (6.8 \times 10^{-4})\, e^{-\frac{\ln 2}{7.4} t}$ |
| $A = \frac{\text{tritium urinary activity (nCi/ml)}}{\text{total administered activity}}$ | |
| $t$ = time (days) | |

PRECEDING PAGE BLANK

Table 2. Effective Half-Lives (Days) of Rapid versus Slow Components in Rats and Cats.

| Cutaneous Absorption in Rats | | |
|---|---|---|
| Compound | Rapid Component | Slow Component |
| MH | 0.5 | 4.2 |
| RH | 0.5 | 3.2 |
| NH | 0.3 | 3.2 |
| CH | 0.4 | 3.5 |
| HTO (control) | -- | 3.2 |

| GI Absorption in Cats | | |
|---|---|---|
| Compound | Rapid Component | Slow Component |
| MH | 0.6 | 9.8 |
| RH | 0.4 | 8.8 |
| NH | 0.6 | 8.3 |
| CH | 0.4 | 7.7 |
| HTO (control) | -- | 7.4 |

Table 3. Urine Distillation Experiments in Rats

| Urine Tritium Activity (nCi/ml) | | | |
|---|---|---|---|
| | Undistilled | Distilled | Ratio* |
| Luminous Compound 24 hours post dose (6) | 370 | 70 | 0.2 |
| Luminous Compound 8 days post dose (5) | 67 | 68 | 1.0 |
| HTO 24 hours post dose (4) | 490 | 560 | 1.1 |

( ) Number of animals.
* Ratio of distilled to undistilled.

Table 4. Percent Absorption of Tritium Activity from Luminous Compounds.

| Compound | Skin Absorption in Rats (8-hour contact time) | | GI Absorption in Cats (Single Oral Dose) | |
|---|---|---|---|---|
| | % Absorbed Observed* (range) | % Absorbed Corrected | % Absorbed Observed* (range) | % Absorbed Corrected |
| NH | 0.10 (0.06 - 0.27) | 0.10 | 0.66 (0.53 - 0.87) | 0.67 |
| RH | 0.19 (0.13 - 0.27) | 0.20 | 2.74 (2.11 - 3.26) | 2.75 |
| CH | 0.59 (0.32 - 0.93) | 0.60 | 4.23 (2.84 - 6.05) | 4.25 |
| MH | 8.79 (5.97 - 11.00) | 8.83 | 21.44 (18.23 - 24.58) | 21.55 |

* Average of 10 animals

Table 5. Percent Total Urinary Tritium Elimination Due to Various Components (time 0 to infinity).

| Compound | Skin Absorption in Rats (8-hour contact time) | | GI Absorption in Cats (Single Oral Dose) | |
|---|---|---|---|---|
| | Rapid Component | Slow Component | Rapid Component | Slow Component |
| NH | 41.3 | 58.7 | 55.1 | 44.9 |
| RH | 43.1 | 56.9 | 88.6 | 11.4 |
| CH | 40.3 | 59.7 | 79.9 | 20.1 |
| Mh | 23.1 | 76.9 | 23.5 | 76.5 |

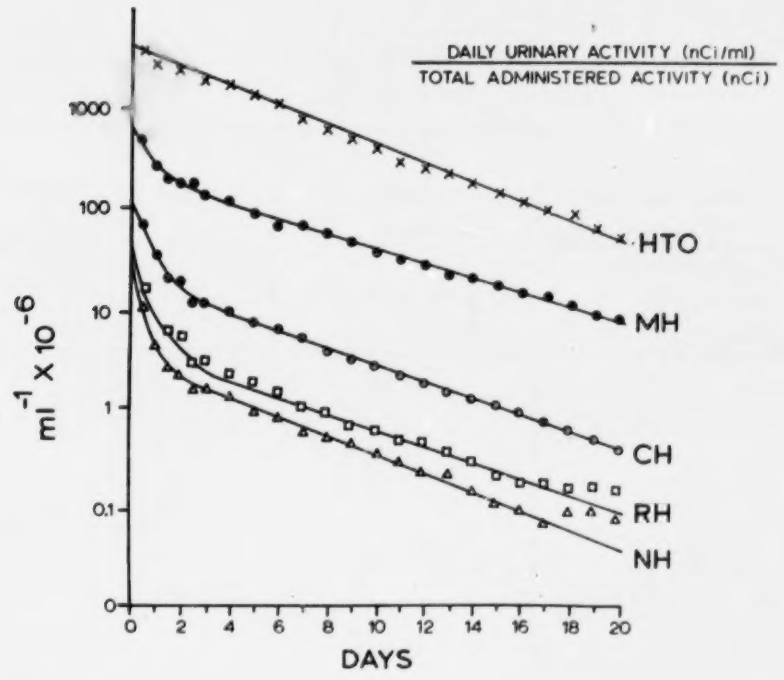



Figure 1. Rat skin absorption of tritium activity from luminous compounds

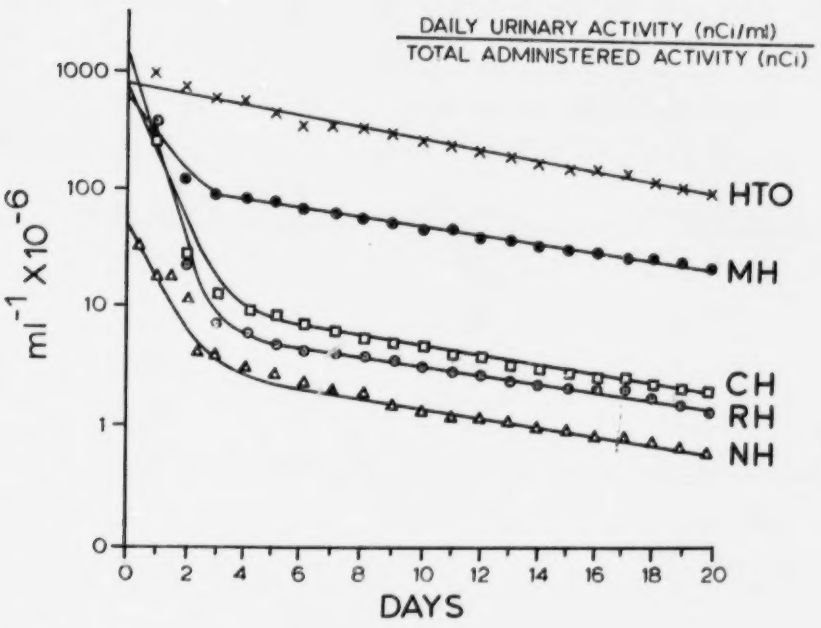



Figure 2. Cat GI absorption of tritium activity from luminous compounds

## APPENDIX A

Six months subsequent to the animal experiments the Southwestern Radiological Health Laboratory (SWRHL)* performed some specific activity measurements on the tritiated luminous compounds used in this study. The results are as follows:

| Company | Activity Determined by the SWRHL mCi/g | Nominal Specific Activity as Labeled on Product mCi/g |
|---|---|---|
| 3M | 57 | 200 |
| NEN | 300 | 600 |
| Canrad | 144 | 250 |
| Radium Chemical | 120 | 250 |

The SWRHL is presently attempting to determine the half-lives of these compounds so extrapolations to the specific activity at the time of the experiment may be made.

All calculations in this paper have been made using the specific activity as supplied by the manufacturers.

---

* Presently Western Environmental Research Laboratory, P.O. Box 15027, Las Vegas, Nevada 89114

## APPENDIX B

### Correction Factor Derivation

$$A_0 = ff\ A_T + sf\ A_0\left[\frac{S_{(0\ to\ t)}}{S_{(0\ to\ \infty)}}\right]$$

where

$A_0$ = observed total excreted activity (time 0 to t)

$A_T$ = true total excreted activity (time 0 to $\infty$)

t = time urine output followed (days)

ff = fraction of total tritium output due to fast component (table 5)

sf = fraction of total tritium output due to slow component (table 5)

$ff + sf = 1$

S = integrated area under slow component urine excretion curve.

Then

$$A_T = \frac{A_0}{ff + sf\left[\frac{S_{(0\ to\ t)}}{S_{(0\ to\ \infty)}}\right]}$$

It is assumed that for the fast component 100 percent of all activity is excreted within the time period followed (minimum of approximately 47 half-lives in these experiments).